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An Improved Collaborative Supply Chain Framework.

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Abstract

Background: *Collaborative Supply Chain is a network of companies, suppliers, manufacturers, distributors and retailers that collaborate to share information, streamline workflows and plan actions to effectively and efficiently meet customer demand. In order to increase responsiveness, save cost, improve product quality and quickly adjust to changes in the marketplace collaboration frequently entails exchanging data, resources and knowledge. With the rapid advancement of technology, it has become essential for businesses to gain a competitive edge by integrating information technology, Internet of Thing (IoT), big data, and cloud computing technologies throughout the supply chain. Although there is an existing framework which consist of five (5) factors which are: collaborative performance system, Decision Synchronization, Integrated Supply Chain Process, Incentive Alignment and Information Sharing, there is a need to improve the system by integrating Data Governance into the supply chain framework and hence, this bridges the gap.*

Aim*: The study aim at improving the existing collaborative supply chain framework by integrating and identifying relevant factors of data governance.*

Method: *The study integrated data governance into a collaborative supply chain framework by considering five (5) additional factors thus: Data Sharing, Frequency, Data anonymity, Shared Analytics and conflict resolution mechanism.Which makes ten (10) factors in the framework.*

Result: *The integration of data governance into the collaborative supply chain framework resulted in an improved collaborative supply chain framework which will in turn, enhance the supply chain management performance in commercial organizations.*

Keywords: *Internet of things, Supply Chain Management, Data Governance, Performance improvement, Data Anonymity.*

1. Introduction

With the rapid advancement of technology, it has become essential for businesses to gain a competitive edge by integrating information technology, IoT, big data, and cloud computing technologies throughout the supply chain. By enhancing transparency and flexibility throughout the supply chain (SC), internet of things (IoT) offers new potential to reduce risks, manage complexity, and bring concrete business benefits (Al-Talib et al., 2020). The supply chain (SC) is a collection of activities and organizations (suppliers, clients, factories, distributors, and retailers) that are motivated to complete client orders. According to the Supply Chain Operations Reference Model (SCOR), the core processes of SC are plan, source, make, deliver, return, and enable (Jia et al., 2020).It is difficult to understate the significance of supply chain innovation to operational management techniques, particularly when it comes to creating unique products and services or utilizing digital technology. Supply chain performance must be improved in order to acquire lasting competitive advantages (Malacina & Teplov, 2022).

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But there are still complexity and difficulties in the world of supply chain management. Natural disasters, changes in the geopolitical environment, and fluctuations in the economy can all disrupt supply networks. Furthermore, supply chain operations are under more pressure due to modern consumers' needs for quicker deliveries and customized items. Traditional supply chain methods, which were frequently reactive, have found it difficult to keep up with the fast-moving business environment (Wu et al., 2019).

A new technology paradigm called the Internet of Things (IoT), often referred to as the Internet of Everything or the Industrial Internet, enables devices to connect with one another via a global network (Lee et al., 2022). The Internet of Things (IoT) is a network of physical objects that are digitally connected to sense, monitor, and interact within an organization and between the organization and its supply chain. This technology enables agility, visibility, tracking, and information sharing to support efficient supply chain planning, control, and coordination.

Ben-daya et al. (2017), proposed definition includes four key features: (i) The requirement for digital connectivity of the physical things in the supply chain; (ii) The nature of this connectivity is proactive allowing for data storage, analysis and sharing; (iii) The communication involves processes within an organization as well as inter-organization transactions covering all major supply chain processes; and (iv) IoT will facilitate planning, control and coordination of the supply chain processes.

The term "Internet-of-Things" is used as an umbrella term to cover a variety of aspects related to the extension of the Internet and the Web into the physical world, through the wide deployment of spatially distributed devices with embedded identification, sensing, and/or actuation capabilities (Ben-daya et al., 2017).

Internet of things can be defined in terms of supply chain management as a collection of physical objects that are digitally connected for sensing, monitoring, and interaction both within and between a company and its SC, cementing agility, visibility, information sharing, and tracking to make it easier to plan, control, and coordinate processes for supply chains (Abdel-Basset et al., 2018).

According to the study by Ghazal et al., (2021) and Tang et al., (2018), the Internet of Things (IoT) is a technological innovation that creates trends, offers a useful planning strategy, and is not just a catchphrase for the business. IoT is regarded as one of the key areas for future technology because of its capabilities, and many sectors are paying attention (Lee et al., 2022). A study by Lee and Lee (2020), identified five main IoT technologies used in IoT-based services and products: RFID, cloud computing, middleware, wireless sensor networks (WSN), and IoT application software. RFID uses radio waves to automatically identify people or items, increasing the system's efficiency and storage capacity. WSN uses autonomous sensors to track objects, while middleware facilitates the integration of legacy technologies. Cloud computing allows pool members to share configurable source computing on-demand. These technologies are widely used in various industries, including logistics, pharmaceuticals, manufacturing, and retail. Data governance defines standards and procedures to ensure the proactive and effective handling and guidance of data management practices such as data replication, data archival, security, data backup ,meta data management (MDM), data traceability and lineage, business glossary mapping, governance council, release and change management, master data and business (Dasgupta et al., 2019).

The practice of authority and control over the administration of data is referred to as data governance. Data governance aims to maximize the value of data and reduce risk and expense associated with it (Abraham et al., 2019).

In answering the call of (Ben-Daya et al., 2022), to include a data governance in the supply chain that seeks to address the problem associated with which data will be shared, how often, data anonymization, shared analytics, and a mechanism for conflict resolution, in this study, a conceptual collaborative supply chain framework is

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improved with the addition of data governance to create a more robust system to improve the performance of supply chain management in business organizations.

2. Related Works

2.1. Resource Base Theory.

A company's ability to function depends on its resources, which can be classified as tangible (land, buildings, equipment) or intangible (trademark, intellectual property, and brand reputation).
Ovidus & Jurevicus (2023), assert that a company depends on its resources to give a competitive advantage, these resources need to be heterogeneous, immobile, and possess the qualities of VRIO (Value, Rarity, Imitability, and Organization). In our study, the resource chosen is the IOT. IoT resources empower internal supply chain capabilities to address external challenges and, in the process, enhance the supply chain competitiveness.

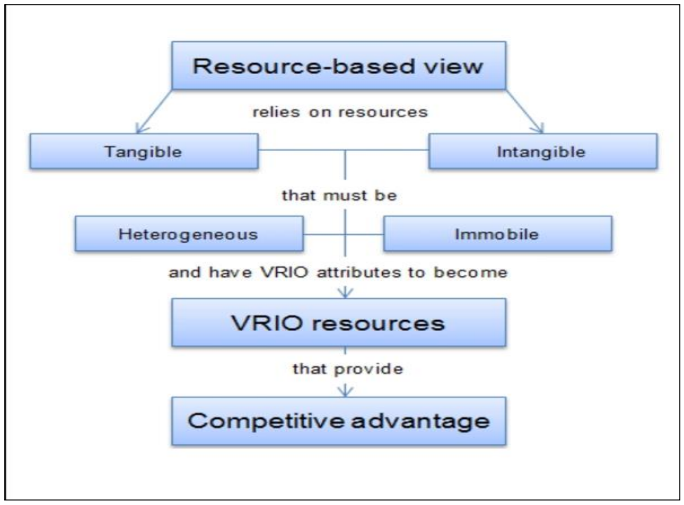

Figure 2.1. Resource-Base View Model. (Source: adopted from Jurevicus. (2023)).

2.2 Impact of internet of things on supply chain collaboration

Ben-Daya et al. (2022), highlight the key role of IoT in enhancing the key elements of collaboration. These elements include information and resource sharing, goal congruence, decision synchronization, effective communication, and joint knowledge creation, he noted that for an effective collaboration to take place, these elements need to be addressed simultaneously.
Ben-Daya et al.(2022) in their study proposed a Collaborative Supply Chain Framework (CSCF) adapted from (Simatupang & Sridharan, 2005) which was made up of the following interconnected elements: collaborative performance system (CPS), information sharing, decision synchronization, incentive alignment, and integrated supply chain processes

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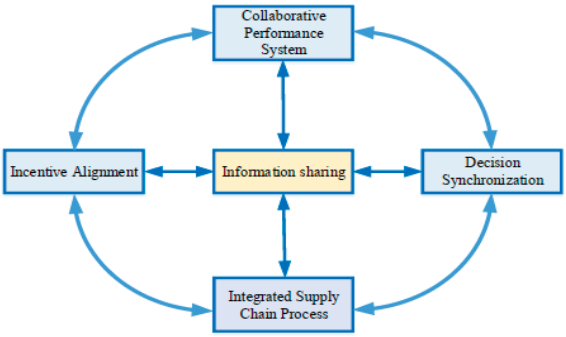

Figure 2.2**.** Collaborative Supply Chain Framework (Source: adopted from Ben Daya et al.(2022)).

2.3 Factors of collaborative supply chain framework

Collaborative Supply Chain system

The process of integrating all parties involved in the completion of a product into a single, cohesive system is known as supply chain integration (Bianchini et al., 2019).To increase their supply chain skills through coordination, collaboration, and agility, companies must leverage their resources in novel ways. This will improve lead time efficiency and performance (Alzoubi et al., 2020)**.**

Decision Synchronization

Supply chains that are highly coordinated and adaptive can reduce the impact of operational failures and prevent a cascading rise-and-fall inventory dynamics,it seeks to show how, given end-to-end visibility, a deep reinforcement learning agent based on the proximal policy optimization algorithm can support business continuity operating in a stochastic and non-stationary environment by synchronizing inbound and outbound flows (Kegenbekov & Jackson, 2021). The proposition that the suggested system can carry out adaptive control in intricate supply chains is stated in the paper's conclusion. Additionally, the study makes the argument that fully functional digital twins of supply chains are a must for scalable real-world applications.

Integrated supply chain process

Coordination, cooperation, and information exchange are the methods by which integration is accomplished. The exchange of information, identification, and communication for both internal and external integration are the primary advantages of IoT for supply chain integration (SCI). In terms of information sharing, numerous studies focused on virtualization for various supply chain types and the application of IoT to facilitate information sharing. IoT has a wide range of effects on supply chain integration, both internal and external, using RFID technology. These effects include transportation, warehousing and inventory management, and more (Cui et al., 2017).

According to Condea et al. (2012), RFID data lowers inventory and raises service standards. By comparing actual inventory with recorded inventory and preventing fraudulent inventory shrinkage, it also increases inventory accuracy.

Incentive Alignment

One of the most important elements for the effective use of supply chain management is incentive alignment (Norrman & Naslund, 2019). Through an empirical exploration and description of the various processes and practices now used in the supply chain incentive alignment business, studies have made a significant contribution

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to both academics and practice. The collection of many incentive mechanisms included in published research is another addition. They also looked into the extent to which the businesses employed various contract mechanisms to provide incentives for alignment with their key clients. Since relationships are typically distinct from one another, the goal is to concentrate on the most significant ties where there should be a greater likelihood of using more advanced mechanisms (i.e., providing incentives for coordination).

Information sharing

The study of Maskey et al. (2019) offers a deeper comprehension of the information-sharing practices of Nepali supply chain actors, which will assist businesses in formulating strategies that will optimize information sharing. In the context of Nepal, a landlocked poor nation, their study empirically examines a long range of characteristics that are predicted to effect information sharing (IS) in supply chains (SC). The proposed model's fitness and the connections between the found factors and information sharing were investigated using exploratory factor analysis and path analysis. The findings indicate that routines of interaction and interpersonal relationships affected the sharing of information, both strategically and operationally. Government support and monitoring was linked to strategic IS, while organizational compatibility, incentives, project payoffs, commitment (inter-organizational), top management commitment, and supply network configuration affected operational IS. The study also offers empirical data on the effects of information exchange in developing nations that are landlocked. The importance of these characteristics in terms of information sharing between developed and developing countries is also identified and discussed in the study, along with their similarities and contrasts.

3. Methodology

3.1 Identification of Factors

According to Ben Daya (2022), it is necessary to integrate Data Governance into supply chain therefore, the study bridge the gap. In this study, relevant literatures were reviewed in other to get data governance as a factor to be integrated into the supply chain framework by considering factors such as “Data Sharing, Frequency, Data Anonymity, Shared Analytics and Conflict Resolution Mechanism”.

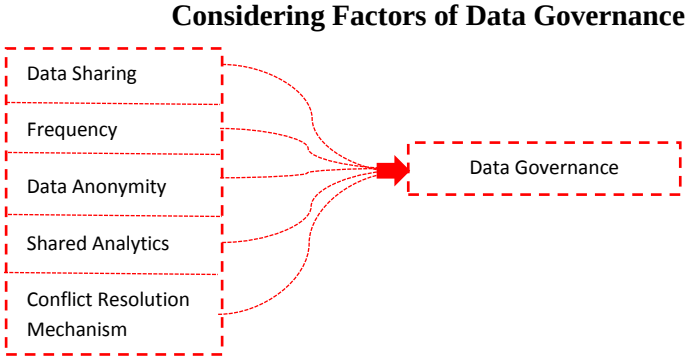

Figure 3.1. Data Governance factors adapted from Ben Daya et al. (2022).

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Data Sharing: Longo et al. (2019) suggest that block chain technology can enhance supply chain performance by allowing transparency in data exchange and continuous validation of data consistency, authenticity, and integrity. This encourages companies to collaborate, build trust, and solve challenges.

Frequency: The COVID-19 pandemic has significantly impacted global supply chains, posing serious risks to individual survival and operational efficiency, as businesses like manufacturers, distributors, retailers, and logistics providers communicate confidential information in real-time (Ivanov & Dolgui, 2020).

Data Anonymity: is a crucial technique for preserving privacy in complex data environments. A multi-model approach, combining techniques like data encryption, machine learning algorithms, block chain technology, data masking, and differential privacy, balances data value and privacy protection (Sahin & Dogru, 2023).

Shared Analytics: enhances supply chain network performance, sustainability, and disruption resilience by optimizing activities and simplifying operations due to the vast volume of data generated by operations (Udokwu et al., 2022).

Conflict Resolution Mechanism: Shahzad et al. (2019) study explores the role of governance mechanisms in choosing effective conflict resolution strategies (CRS) in buyer-supplier relationships. The study highlights the importance of contract, interdependence, trust, and communication in achieving better relationship performance and competitive advantage. The chosen strategies can either strengthen or weaken partnership success.

4. Result and Discussions

4.1 Improved collaborative supply chain framework

Figure 4.2 shows how data governance will be integrated into the supply chain framework. And also discuss the five factors (Data sharing, frequency, data anonymity, Shared analytics and conflict resolution mechanism) to be considered under data govern

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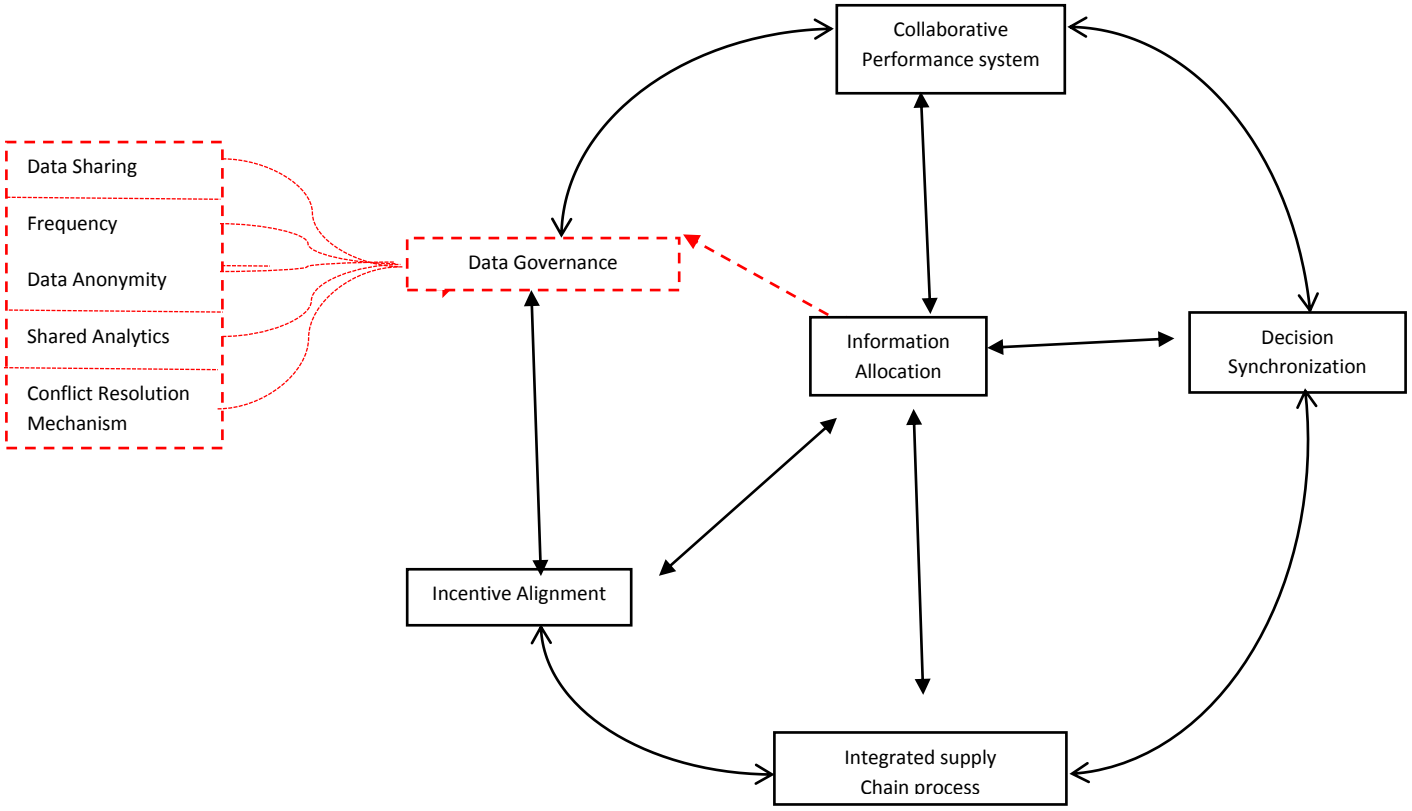

Figure 4.2. An Improve Collaborative Supply Chain Framework, adapted from Ben Daya et al. (2022)

Data Governance

The exercise of authority and control over data management is referred to as data governance (Abraham et al., 2019). Data governance aims to reduce risk and expense associated with data while optimizing the value of data. Even if data governance has become more significant recently, a comprehensive approach to data governance that might direct scholars and practitioners. According to Gartner, it is the process of assigning decision-making authority and accountability for an asset, creating policies that support business goals, investing in resources that support those goals, putting in place safeguards to ensure corporate policy compliance, and guaranteeing proper corporate risk management (Dasgupta, 2021).

The goal of this study is to bridge the gap and provide a conceptual framework for supply chain management by integrating data governance factors included as: .

- Data sharing
- Frequency
- Data anonymity
- Shared analytics
- Conflict resolution mechanism

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Data Sharing

Blockchain is a promising information technology that has a number of possible uses in the operations and supply chain domains. Blockchain can address the issue of immutable ledgers dispersed among several chain participants by utilizing distributed software architecture and cutting-edge computation (Helo & Hao, 2019).

A supply chain can exchange a wide range of information, including business, tactical, strategic, and logistics-related information (Lotfi et al., 2013). Several well-known categories of information include:

1) Inventory Information
2) Sales Data;
3) Sales Forecasting;
4) Order Information;
5) Product Ability Information;
6) Exploitation Information of New Products; and
7) Other Information

According to Huang et al. (2020), product lifecycle management is the process of "managing products across their lifecycles," starting from the conception of a product and continuing until its retirement and disposal. Professor Grieves (Grieves M, 2014) first introduced the idea of a "digital twin" in 2003 as a way to manage the product lifecycle in virtual space. A "digital twin" was defined as a combination of three elements: a physical product in real space, a virtual product in virtual space, and data transmission between these two spaces.

Companies involved in a supply chain are less likely to exchange data when partners cannot be completely trusted and information is reasonable (Longo et al., 2019). In this situation, he suggested using blockchain technology to enable businesses to share data with partners at varying degrees of visibility and to use the blockchain to verify the authenticity, integrity, and consistency of data over time, thereby fostering trust. The findings of his research demonstrate how block chain technology pushes rival supply chain businesses to exchange information and data in order to overcome problems with trust and cooperation. hence improving the performance of the supply chain.

Frequency

Various companies or participants, including manufacturers, distributors, retailers, and logistics providers, exchange information and data It is made easier for SC partners to share protected information in almost real-time, which has an impact on risk management within the SC. The operational effectiveness of supply chains (SCs) and the survival of individual members have been seriously jeopardized by a number of accidents that have occurred in recent years. A case in point is the COVID-19 pandemic, which has posed a significant danger to intricate worldwide supply networks (Ivanov & Dolgui, 2020).

Supply networks can recover more quickly and become less susceptible to interruptions when they are resilient. Digital technology is making many of the current supply chain resilience solutions easier to implement. One of the most exciting new technologies, blockchain allows for automation through smart contracts and transparent, safe, and timely data exchange (Lohmer et al., 2020).

Data Anonymization:

One method of protecting data privacy is called "data anonymization," which is taking identifying information out of data sets without sacrificing usefulness.(Sahin & Dogru, 2023) Robust solutions for data anonymization are necessary to protect sensitive and personal information due to the growing need for data privacy and the

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complexity of data environments. By combining methods such as data masking, differential privacy, machine learning algorithms, block chain technology, and data encryption, a multi-model approach to data anonymization can achieve the best possible balance between privacy protection and data value. The Security-Centric Enterprise Data Anonymization Governance Model, a formal framework for handling data privacy in the government, banking, and healthcare sectors, is presented in this article. The approach guarantees that legal and regulatory obligations are met as well as best practices are followed. The essay advocates for a multi-model strategy that integrates several technologies and approaches to overcome issues in implementing data anonymization strategies, such as preserving data utility and preventing re-identification. Despite its complexity and lack of understanding, anonymization is essential for the proper and secure gathering, handling, and exchange of data (Mackey, 2019). In essence, anonymization is the process of making personal information non-personal.

Shared Analytics:

A key factor in enhancing and streamlining operations inside a supply chain (SC) network is data analytics (DA). Owing to the massive volume of data produced by the different SC processes, DA approaches have been used in a variety of ways to enhance the SCM network's overall performance, sustainability, and disruption resistance (Udokwu et al., 2022). As per the findings of a study conducted by (Patrick, P et al., 2021) to examine the various aspects of data analytics in supply chain management. It has been noted that a few different ways data analytics are used in the supply chain are:

- Improve the *performance* of SCM processes
- Improve the *resilience* of SCM towards potential disruptions that may occur in the network
- Improve the *sustainability* of the network with respect to using 'green' inputs and outputs in the network.

Moreover the study by Seyedan and Mafakheri, (2020) identified several applications such as:
Prescriptive capabilities are provided for handling future circumstances through the combination of simulation models and prediction algorithms. They said these could be taken into consideration for future applications. IOT application to address issues related to data collection Reverse logistics involves the direct integration of computer systems with actual objects in the supply chain. Note how social media is used in integrating and developing relationships by directly connecting organizations to suppliers and customers; how it facilitates knowledge sharing to improve the operational efficiency of SCM; how it is used by organizations to forecast and develop new products; and how it is a useful source of information during disruptive events in a SC network in order to explore the future operations in supply chain management (Devi & Ganguly, 2021).

Conflict Resolution mechanism

A study by (Shahzad et al., 2019), presented an integrated framework and examines the enabling roles of governance mechanisms (i.e., contract, interdependence, trust, and communication) in the selection of effective conflict resolution strategies (CRS), which in turn facilitate buyer-supplier relationship (BSR) performance. Effective management of buyer-supplier relationships drives firms towards superior relationship performance and competitive advantage. The results show how the governance structures influence the enterprises' choice of CRS, based on actual facts. While the legalistic technique is still the final option affected by many governance systems, the problem-solving strategy is the better option. In order to resolve inter-organizational issues, corporations must compromise because of their mutual trust and interdependence. Additionally, the techniques that businesses choose may improve or worsen the success of their relationships. According to Yang et al. (2017), buyer-supplier

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conflict results from discrepancies between desired and real actions and is a representation of the dispute between the two parties.

Legalistic strategy and collaborative strategy are the two dispute resolution approaches described in a study by (Shahzad et al. 2019), it explained that compared to other collaborative methods (such as issue solving and compromising), the juridical strategic approach is more assertive. As a result, this legal strategy may make future disputes more likely because it may cause emotional harm to one spouse as well as rigidity and dissatisfaction between both. Similarly, other researchers discovered that the legalistic approach had a detrimental effect on performance and satisfaction, noting that it reduces the possibility of cooperative efforts to resolve conflicting issues, which destroys relationships. In a study by Jiang et al. (2021), that uses the world's largest coal supplier in China as a case study and genetic algorithms, it is demonstrated that the most efficient way to resolve conflicts in the original plans is to modify them from a global viewpoint, which has a strong relationship with the overall interests.

5. Conclusion

The study investigates how data governance can be incorporated into an already-existing supply chain collaborative framework. It emphasizes the importance of this integration in enhancing supply chain collaboration through an examination and review of relevant literatures. Quality of data, security, and overall efficiency are highlighted. The article advances supply chain management methods in the era of improved cooperation and data governance by offering useful suggestions and addressing some important data governance components such as Data sharing, frequency, data anonymity, shared analytics and conflict resolution mechanism. The study's conclusion enhances supply chain management performance in commercial organizations by incorporating data governance into a conceptual collaborative supply chain architecture.

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